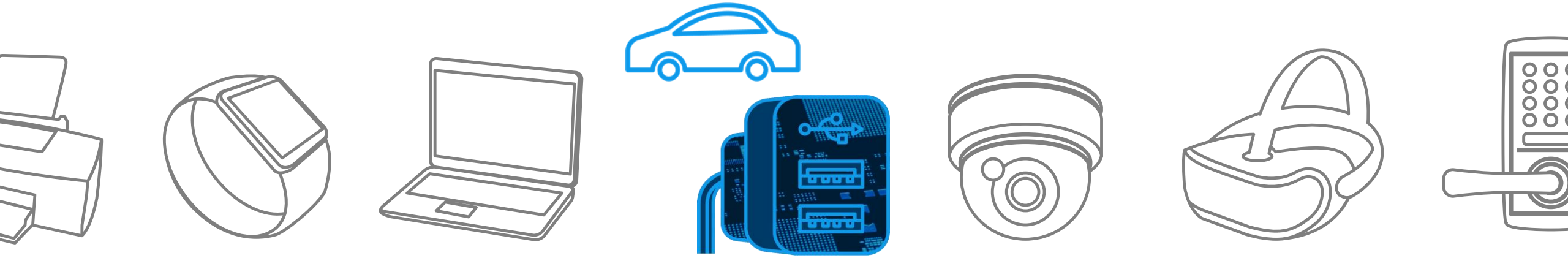
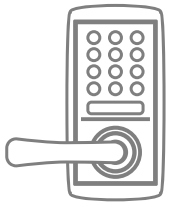
TOSHIBA

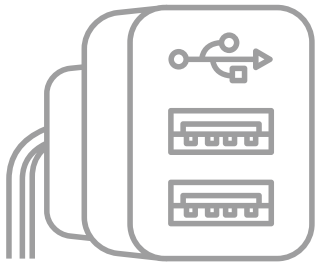
R21

Automotive USB Power Charger

Solution Proposal by Toshiba

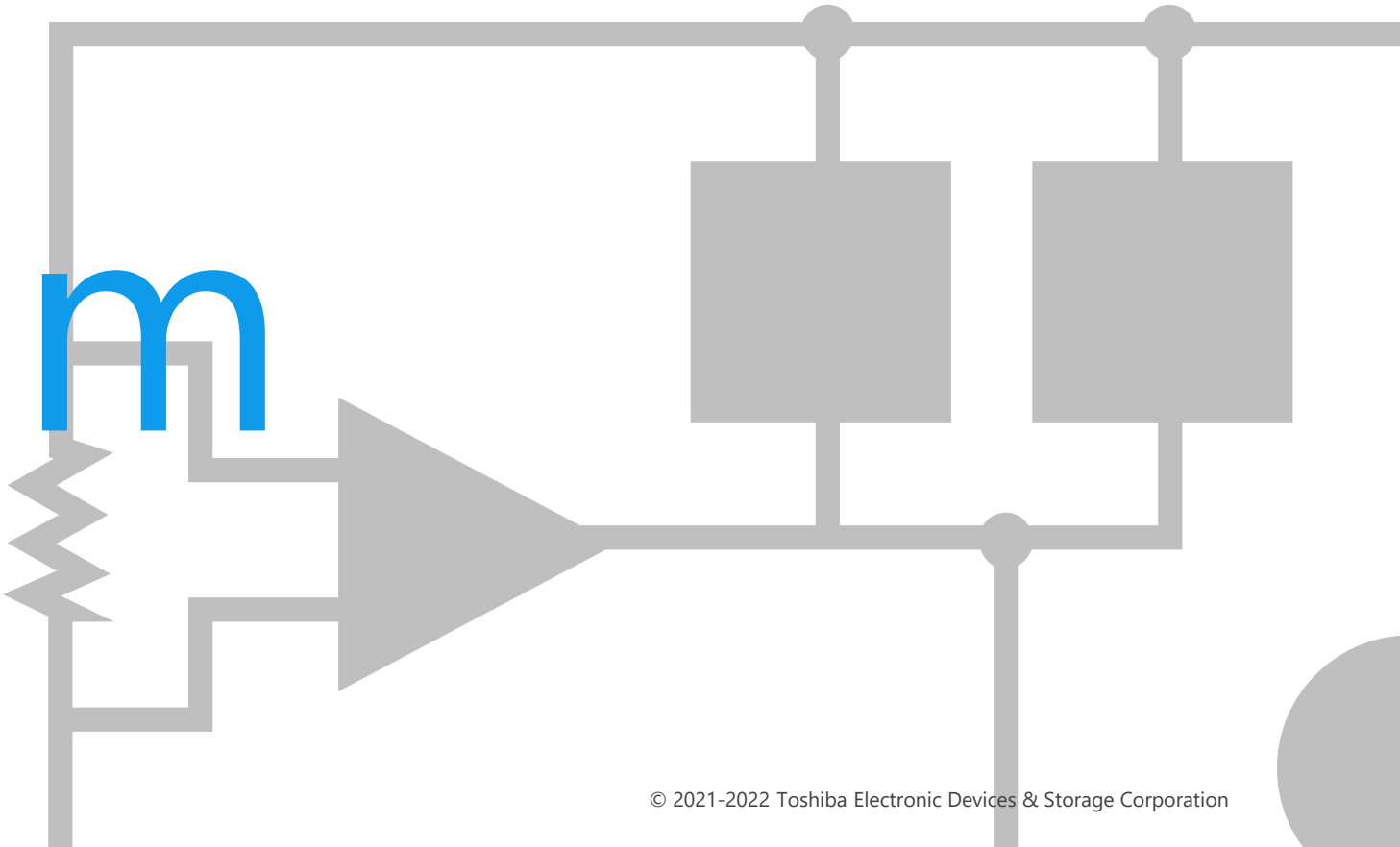




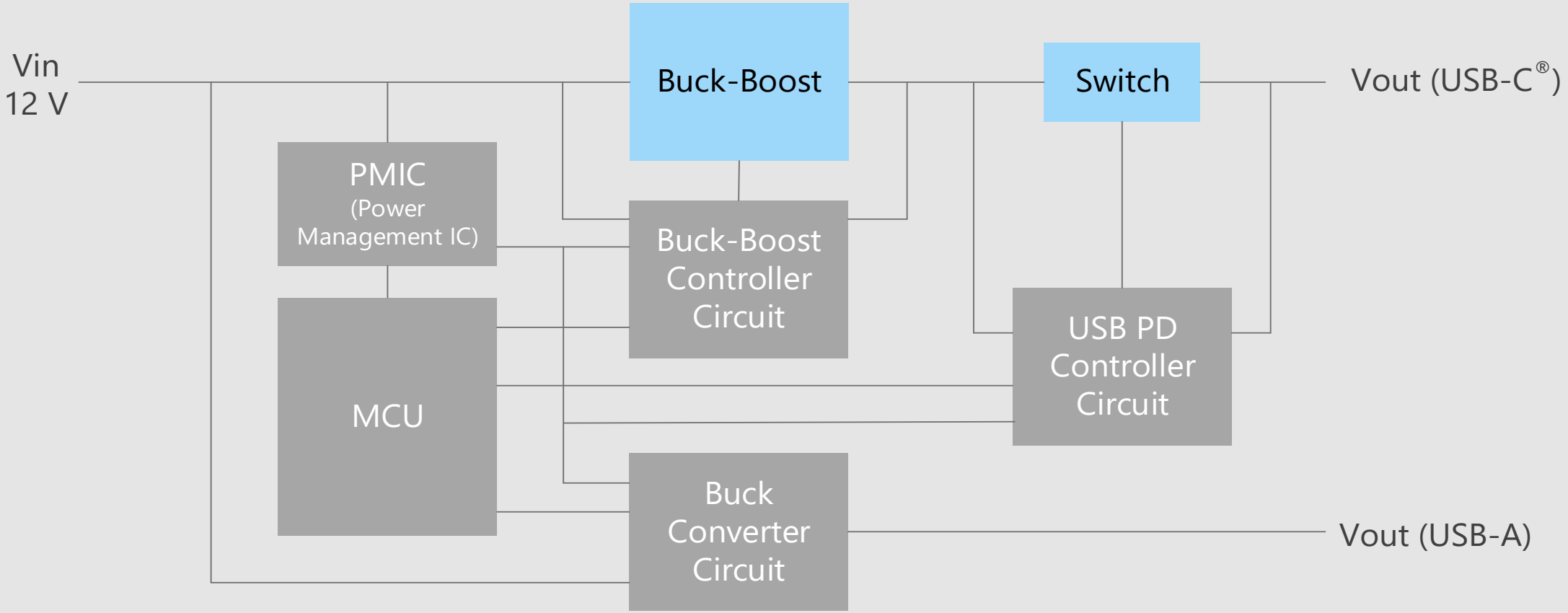


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

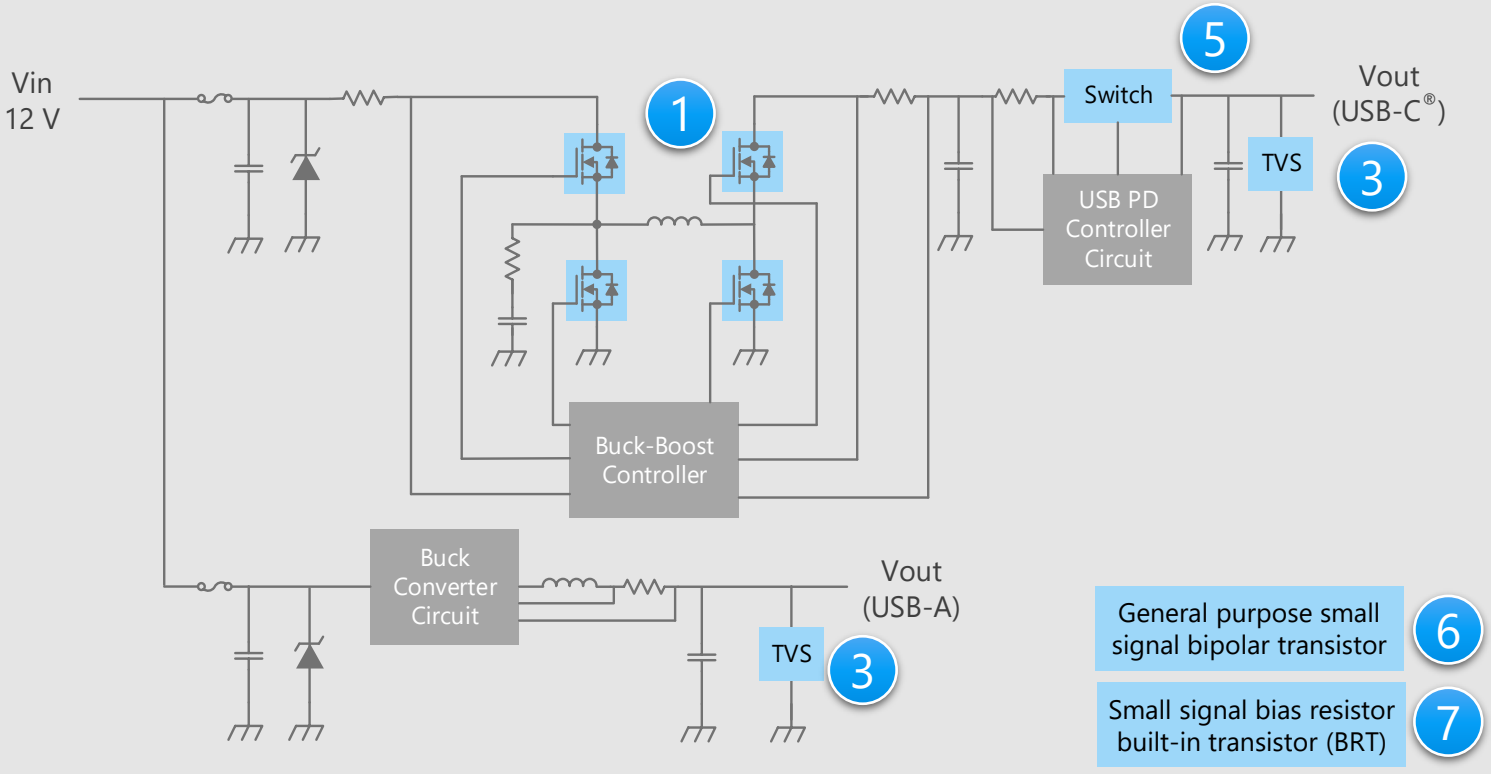


USB Power Charger　Overall block diagram



USB Power Charger　Detail of cigar socket type

Circuit for cigar socket type



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Criteria for device selection

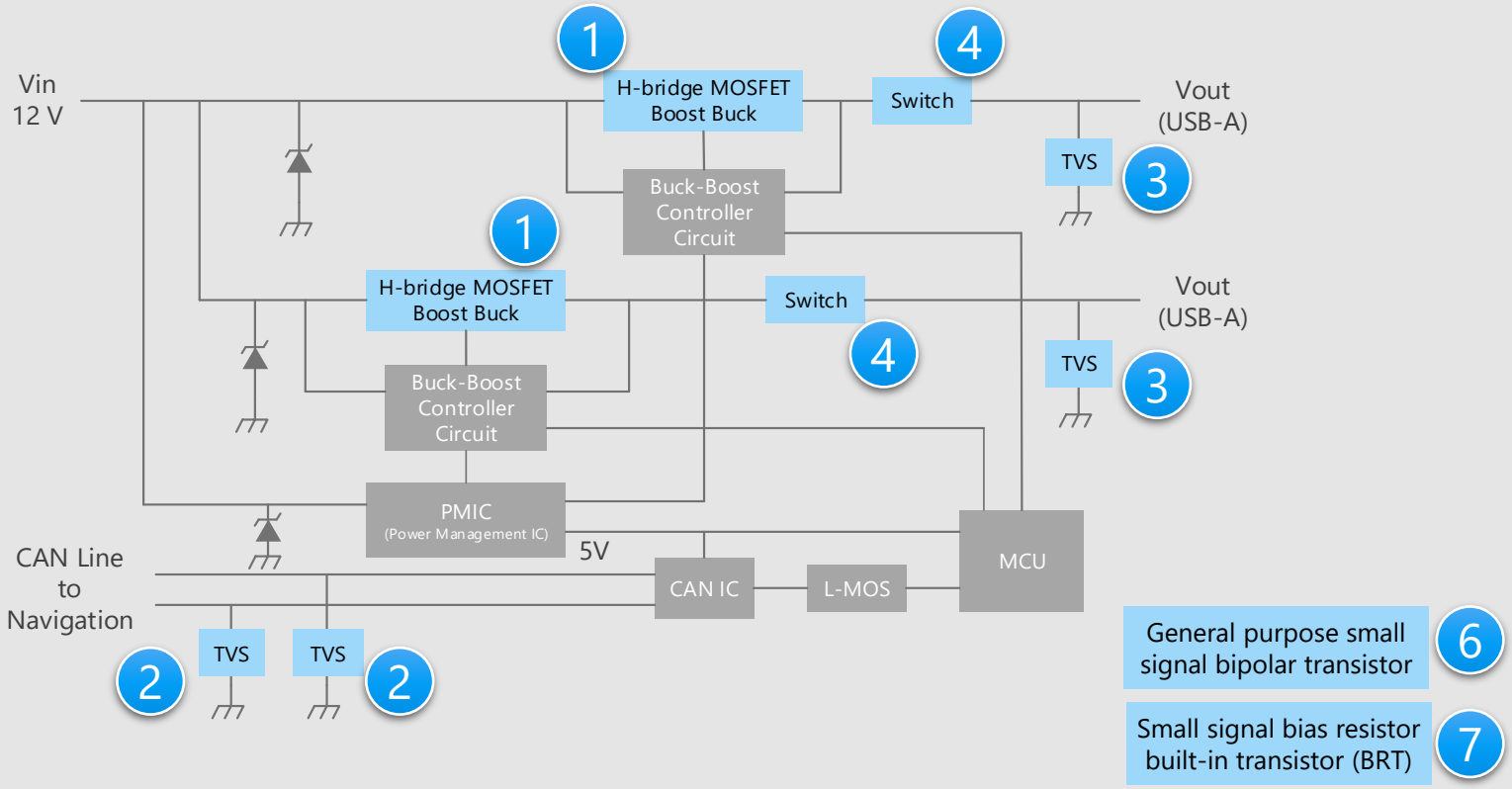
- It is necessary to select the product with the suitable voltage and current ratings for each application.
- It is necessary to select a gate driver according to the characteristics of the switching device to be driven.
- A small surface mount package is suitable for realizing miniaturization of the ECU.

Proposal from Toshiba

- **Low on-resistance contributes to low power consumption of the system**
  U-MOS Series 40 V N-ch MOSFET　1
- **Suitable for ESD protection**
  TVS diode (for CAN communication)　3
- **Low on-resistance contributes to low power consumption of the system**
  U-MOS Series -40 V / -60 V P-ch MOSFET　5
- **Extensive product lineup**
  General purpose small signal bipolar transistor　6
  Small signal bias resistor built-in transistor (BRT)　7

USB Power Charger　Detail of accessory type

Circuit for accessory type



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Criteria for device selection

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- It is necessary to select a gate driver according to the characteristics of the switching device to be driven.
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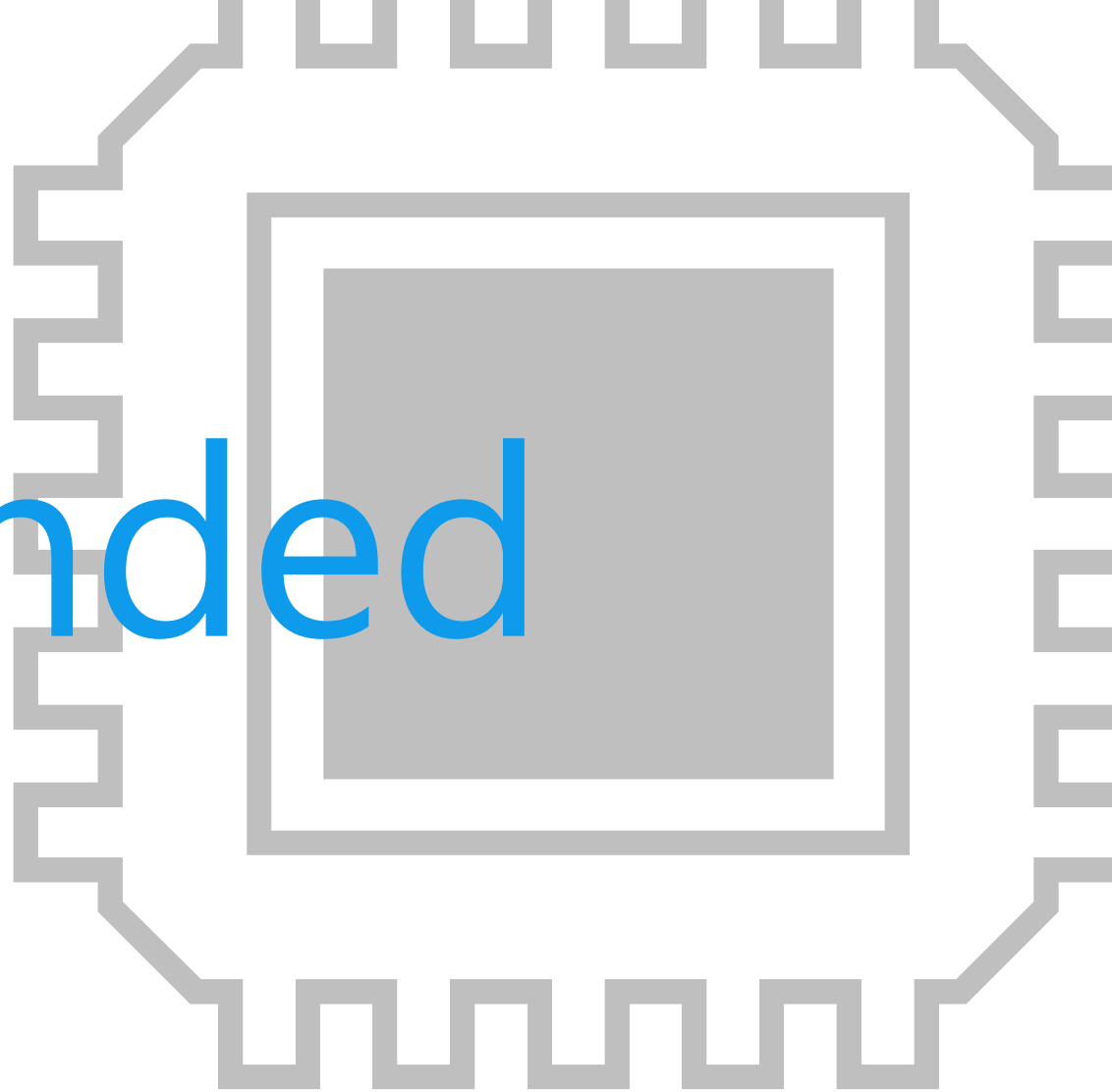
Proposal from Toshiba

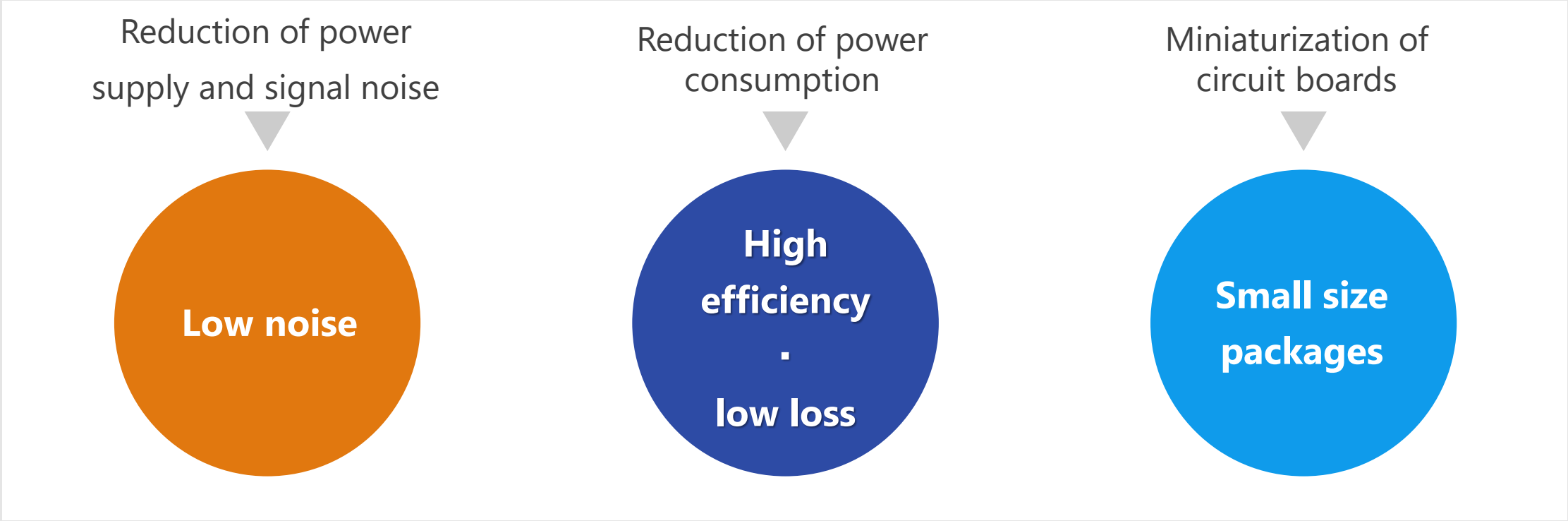
- **Low on-resistance contributes to low power consumption of the system** 1
  U-MOS Series 40 V N-ch MOSFET
- **Suitable for ESD protection** 2 3
  TVS diode (for CAN communication)
  TVS diode (for high speed communication)
- **Low on-resistance, small and high power dissipation package** 4
  Semi-power MOSFET
- **Extensive product lineup** 6 7
  General purpose small signal bipolar transistor
  Small signal bias resistor built-in transistor (BRT)

Recommended Devices



Device solutions to address customer needs

As described above, in the design of USB Power Charger, **“Reduction of power supply and signal noise”**, **“Reduction of power consumption”** and **“Miniaturization of circuit boards”** are important factors. Toshiba’s proposals are based on these three solution perspectives.



Device solutions to address customer needs

		Low noise	High efficiency · low loss	Small size packages
1	U-MOS Series 40 V N-ch MOSFET	●	●	●
2	TVS diode (for CAN communication)	●		●
3	TVS diode (for high speed communication)	●		●
4	Semi-power MOSFET		●	●
5	U-MOS Series -40 V / -60 V P-ch MOSFET		●	●
6	General purpose small signal bipolar transistor			●
7	Small signal bias resistor built-in transistor (BRT)			●

1 U-MOS Series 40 V N-ch MOSFET

XPN3R804NC / TK1R4S04PB / XPHR7904PS / TPWR7904PB / XPJR6604PB* / XPQR3004PB

Low noise | High efficiency · Low loss | Small size package

Value provided

The latest processes enables low on-resistance and low noise, thereby reducing power consumption.

1 Low loss (reduced on-resistance)

Using low on-resistance technology to contribute to reduced power consumption systems.
On-resistance of 44 % reduction per unit area.
(compared to Toshiba's U-MOSⅧ-H products)

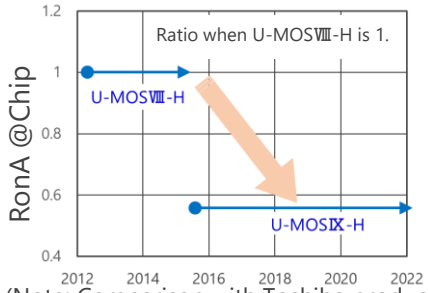
2 Small and low loss package

By adopting a Cu clip structure and a double-sided heat dissipation structure, low loss and high heat dissipation are realized.
Wettable Flank (WF) package contributes to good mountability.

3 Low noise (low EMI)

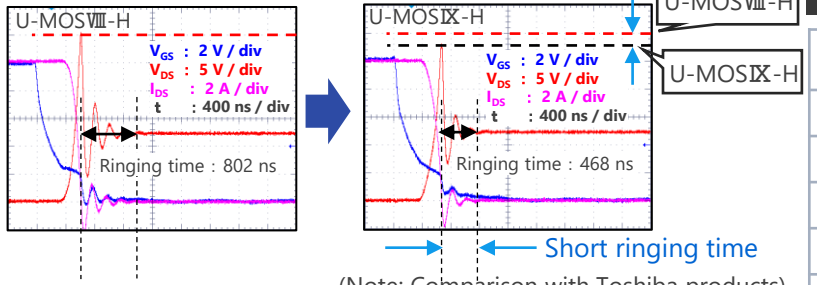
Improved chip process reduces surge voltage and ringing time.

Low loss: RonA trend



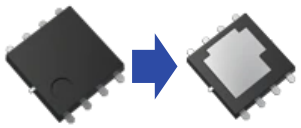
(Note: Comparison with Toshiba products)

Low noise: Switching waveform



(Note: Comparison with Toshiba products)

DSOP Advance(WF)L double-sided cooling package



Thermal resistance is reduced by 76 % @t = 3 s, mounted on board
Compared to Toshiba's SOP Advance(WF)

S-TOGL™ & L-TOGL™ Cu clip structure

High Current & Low resistance

Lineup

Part number	Rated drain current [A]	On-resistance (Max) [mΩ] @V_{GS} = 10 V	Package
XPN3R804NC	40	3.8	TSON Advance(WF)
TK1R4S04PB	120	1.35	DPAK+
XPHR7904PS	150	0.79	SOP Advance(WF)
TPWR7904PB	150	0.79	DSOP Advance(WF)L
XPJR6604PB*	(200)	(0.66)	S-TOGL™
XPQR3004PB	400	0.30	L-TOGL™

* : Under development (Values enclosed in parentheses are tentative specifications. Specifications are subject to change without notice.)

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2 TVS diode (for CAN communication)

DF3D18FU / DF3D29FU / DF3D36FU

Low noise | High efficiency · Low loss | Small size package

Value provided

TVS diodes prevent system damage and malfunction caused by electrostatic discharge (ESD).

1 Improve ESD pulse absorbability

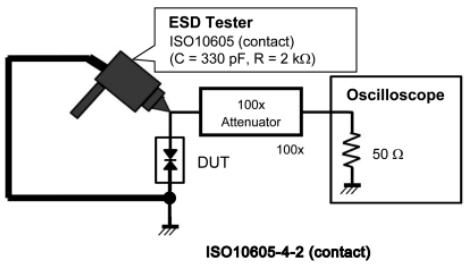
Toshiba proprietary Zener process improves the ESD pulse absorption of TVS diodes.
(Achieving both low dynamic resistance R_{DYN} and low capacitance between terminals C_t)

2 Supports CAN, CAN FD and FlexRay

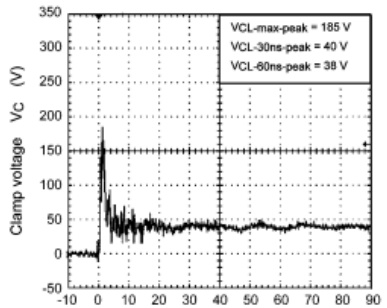
These are products applicable to in-vehicle LAN communication such as CAN, CAN FD and FlexRay.

3 High ESD immunity

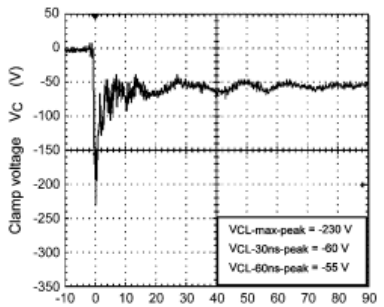
V_{ESD} > ±30 kV @ISO 10605
V_{ESD} > ±20 kV @IEC 61000-4-2 (Level 4)



ISO10605-4-2 (contact)



DF3D36FU +15kv (ISO10605)



DF3D36FU -15 kV (ISO10605)

Lineup

Part number	DF3D18FU	DF3D29FU	DF3D36FU
Package	USM (SOT-323) 		
V_{ESD} [kV] @ISO 10605	±30	±30	±20
V_{RWM} (Max) [V]	12	24	28
C_t (Typ. / Max) [pF]	9 / 10		6.5 / 8
R_{DYN} (Typ.) [Ω]	0.8	1.1	1.5

(Note) The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.
This product is an ESD protection diode and cannot be used for purposes other than ESD protection.

◆Return to Block Diagram TOP

3 TVS diode (for high speed communication)

DF2S5M4FS / DF2S6M4FS

Low noise | High efficiency · Low loss | Small size package

Value provided

TVS diodes prevent system damage and malfunction caused by electrostatic discharge (ESD).

1 Improve ESD pulse absorbability

Toshiba proprietary snapback technology (4th-Gen. process) improves ESD pulse absorption compared to Toshiba previous products.
(50 % reduction in R_{DYN})

2 Supports Ethernet and LVDS [Note]

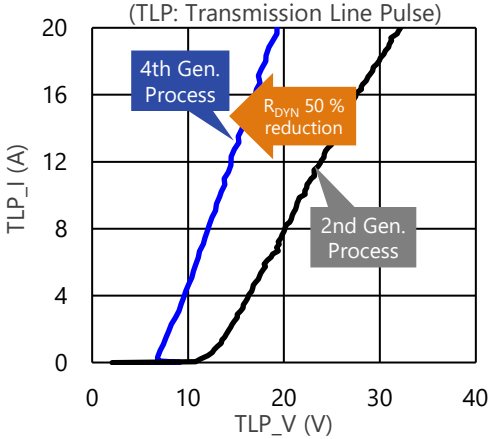
These are products applicable to high speed communications (Gbps orders) such as Ethernet and LVDS.

[Note] Low voltage differential signaling

3 High ESD immunity

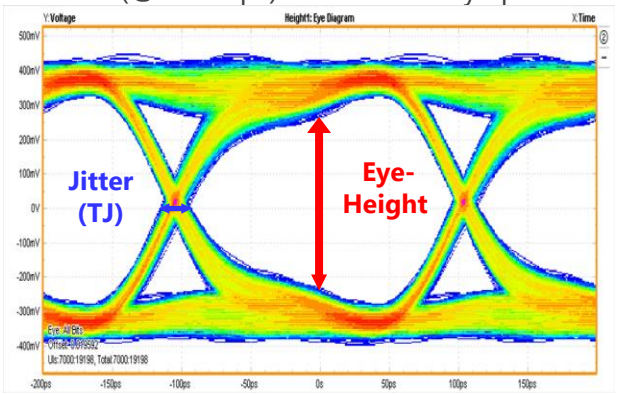
V_{ESD} > ±30 kV @ISO 10605
V_{ESD} > ±20 kV @IEC 61000-4-2 (Level 4)

ESD Pulse Absorption Performance
(TLP: Transmission Line Pulse)



(Note: Toshiba internal comparison)

LVDS (@4.8 Gbps) DF2S6M4FS Eye pattern



Lineup

Part number	DF2S5M4FS	DF2S6M4FS
Package	SOD-923	
V_{ESD} [kV] @ISO 10605	±30	±30
V_{RWM} (Max) [V]	3.6	5.5
C_t (Typ. / Max) [pF]	0.45 / 0.55	
R_{DYN} (Typ.) [Ω]	0.35	

(Note) This product is an ESD protection diode and cannot be used for purposes other than ESD protection.

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4 Semi-power MOSFET

SSM6K810R / SSM6K809R / SSM6K804R / SSM6J808R

Low noise | High efficiency · Low loss | Small size package

Value provided

Low on-resistance, small and high power dissipation packages contribute to miniaturization and low power consumption of the systems.

1 Low loss (reduced chip resistance)

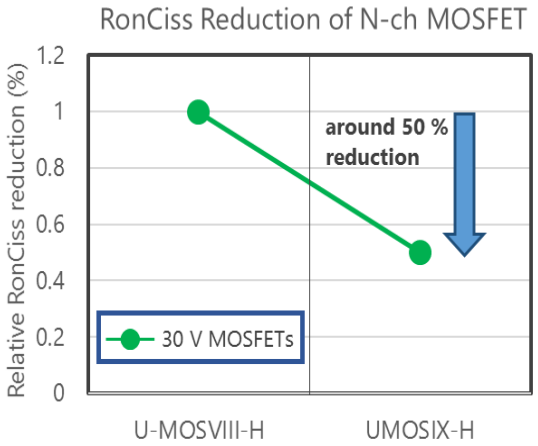
Using low chip resistance technology to contribute to reduced power consumption systems.

2 Small and high power dissipation package

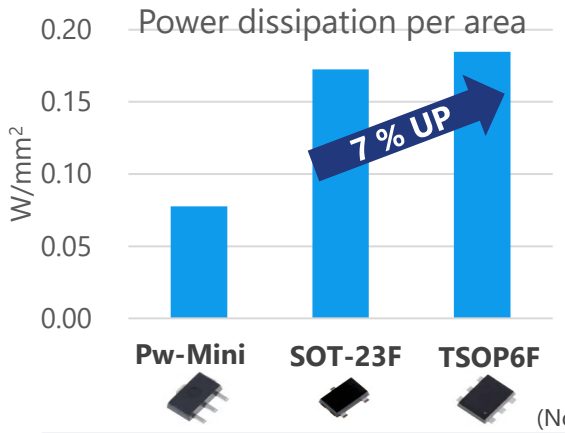
Small and high power dissipation packages contribute to space saving during mounting. TSOP6F (2.9 x 2.8 mm)

3 AEC-Q101 qualified

AEC-Q101 qualified and can be used for a wide range of automotive applications.



(Note: Comparison with Toshiba products)



(Note: Comparison with Toshiba products)

Small and high power dissipation

Lineup

Part number		SSM6K810R	SSM6K809R	SSM6K804R	SSM6J808R
Package		TSOP6F			
V_{DSS} [V]		100	60	40	-40
I_D [A]		3.5	6	12	-7
$R_{DS(ON)}$ [mΩ] @$\|V_{GS}\|$ = 4.5 V	Typ.	65	36	12	35
	Max	92	51	18	48
Polarity		N-ch	N-ch	N-ch	P-ch

◆Return to Block Diagram TOP

5 U-MOS Series -40 V / -60 V P-ch MOSFET

XPN9R614MC / XPH3R114MC / XPH8R316MC* / TJ90S04M3L

Low noise | High efficiency · low loss | Small size packages

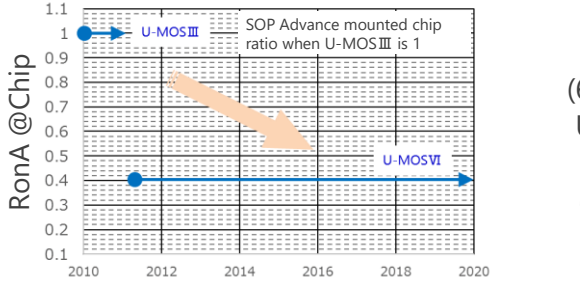
Value provided

Low on-resistance contributes to reduce system power consumption.

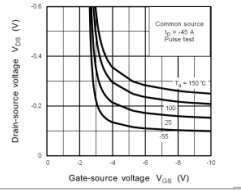
1 Low loss (reduced on-resistance) and logic level drive

Using a low on-resistance technology contributes to reduce system power consumption.
A lineup of logic level drive type is supported.
The on-resistance per area is reduced by 60 %.
(compared to Toshiba's U-MOSⅢ products)

Low loss: RonA reduction trend



(Note: Comparison with Toshiba products)



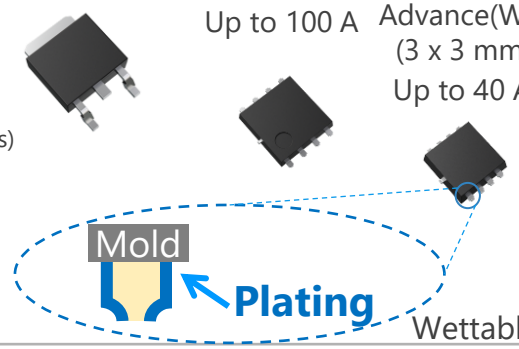
Logic level drive
TJ90S04M3L
V_{DS} - V_{GS}

Large current, small size, high power dissipation package

DPAK+
(6.5 x 9.5 mm)
Up to 90 A

SOP Advance(WF)
(5 x 6 mm)
Up to 100 A

TSON Advance(WF)
(3 x 3 mm)
Up to 40 A



Wettable Flank (WF) structure

2 Small and low loss packages

By adopting a Cu connector structure, a low loss and high power dissipation package is realized.
Wettable Flank (WF) package contributes to good mountability.

Lineup

Part number	Rated drain-source voltage [V]	Rated drain current [A]	On-resistance (Max) [mΩ] @V_{GS} = -10 V	Package
XPN9R614MC	-40	-40	9.6	TSON Advance(WF)
XPH3R114MC	-40	-100	3.1	SOP Advance(WF)
XPH8R316MC*	-60	(-90)	(8.3)	
TJ90S04M3L	-40	-90	4.3	DPAK+

* Under development (Values enclosed in parentheses are tentative specifications. Specifications are subject to change without notice.)

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6 General purpose small signal bipolar transistor

2SC2712 / 2SA1162 / 2SC4116 / 2SA1586 / TTA501 / TTC501 and others

Low noise | High efficiency · low loss | Small size packages

Value provided

Extensive product lineup to meet customers' needs.

1 Extensive lineup of packages

Various packages such as 1-in-1, 2-in-1 are provided and suitable products for circuit board design are selectable.

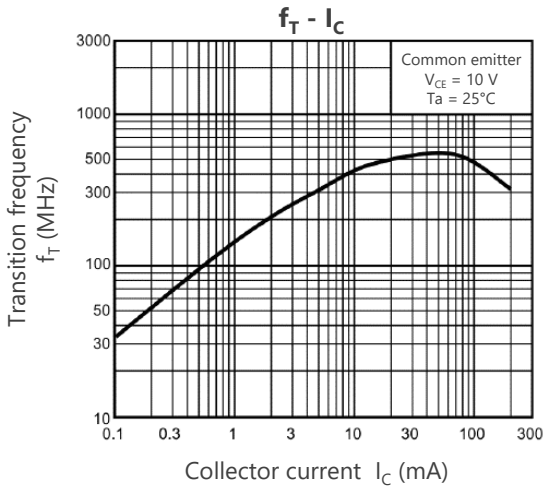
2 Extensive product lineup

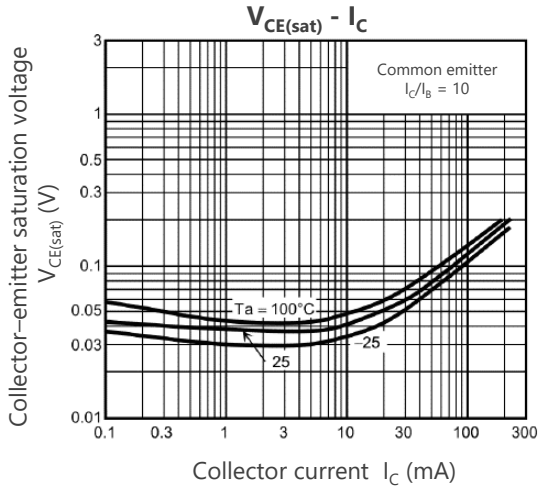
Various product lineups, such as general purpose, low noise, low $V_{CE(sat)}$ and high current types are provided. Products can be selected in accordance with the application.

3 AEC-Q101 qualified

AEC-Q101 qualified and can be used for various automotive applications.

Characteristic examples of 2SC2712





Lineup

Package			SOT-23F		USM (SOT-323) UFM (SOT-323F)*		S-Mini (SOT-346)	
Classification	$\lvert V_{CEO} \rvert$ [V]	$\lvert I_C \rvert$ [mA]	NPN	PNP	NPN	PNP	NPN	PNP
General purpose	50	150			2SC4116	2SA1586	2SC2712	2SA1162
	50	500					2SC3325	2SA1313
Low noise	120	100			2SC4117	2SA1587	2SC2713	2SA1163
High current	50	1700				2SA2195*		
	50	2000		TTA501				
	50	2500	TTC501					

* indicates UFM package

◆Return to Block Diagram TOP

7 Small signal bias resistor built-in transistor (BRT)

RN1907FE / RN2907FE / RN1901 / RN2901 Series

Low noise | High efficiency · low loss | Small size packages

Value provided

Extensive product lineup to meet customers' needs.

1 Built-in bias resistor type
(BRT : Bias Resistor built-in Transistor)

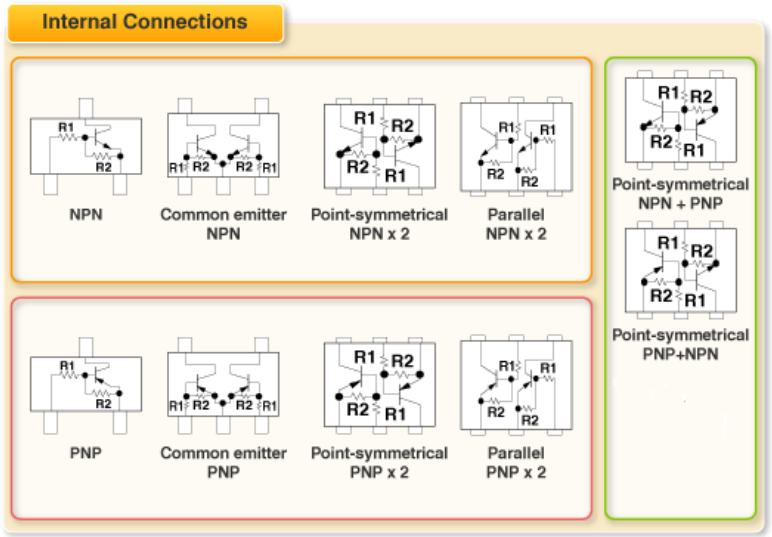
The BRTs contribute to reduction of the number of components, assembly workload and mounting area of circuit boards.

2 Extensive lineup of package and pin assignment

Various package lineups, such as 1-in-1, 2-in-1 and various pin assignment type are provided and suitable products for circuit board design are selectable.

3 AEC-Q101 qualified

AEC-Q101 qualified and can be used for various automotive applications.



Lineup

Part number		NPN (BRT)	PNP (BRT)
Package	ES6 (SOT-563) 	RN1907FE	RN2907FE
	US6 (SOT-363) 	RN1901	RN2901
V_{CEO} [V]		50	-50
I_C [mA]		100	-100

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